**Mission:** To provide the data services, tools, and cyberinfrastructure leadership that advance Earth system science, enhance educational opportunities, and broaden participation.

**Vision:** Unidata recognizes that an integrated approach that transcends discipline and geographic boundaries is needed to understand and address societally important problems such as weather prediction, El Nino-Southern Oscillation, climate change, and the water cycle. The success of the geosciences enterprise depends heavily on the availability of a state-of-the-art, robust, and flexible cyberinfrastructure, transparent access to high-quality data from diverse sources, and requisite tools and services to use the data effectively.

Unidata's vision for the next five years calls for providing comprehensive, well-integrated, end-to-end data services. These include an array of functions for collecting, finding, and accessing data; data/content management tools for generating, cataloging, and exchanging metadata; and submitting/publishing, sharing, analyzing, visualizing, and integrating data. When this vision is realized, users — no matter where they are, how they are connected to the Internet, or what computing device they use — will be able to find and access a plethora of geosciences data, experience how all of the aforementioned services work together, and use Unidata-provided tools and services both productively and creatively in their research, education, and outreach activities.

A related element of that vision is that a user will be able to work within his or her own community data system, but will seamlessly be able to find, access, and use data from the systems of the other disciplines without having to learn entirely foreign interfaces to get at the data and without having to learn and employ a host of new data formats and conversion programs.

**Introduction**

Unidata had another productive year with numerous contributions in the data services area toward the advancement of education and science, and many significant accomplishments, including a successful review of the Unidata core-funding proposal by a distinguished panel appointed by the National Science Foundation.

We were extremely proud to learn earlier this year that Unidata’s founding director, Dave Fulker, is the recipient of this year’s AMS Cleveland Abbe Award for his “visionary foresight, creative leadership in community building, and pioneering information technology contributions to advance meteorological data use in education and research.”

1 Unidata is also developing services so a program or service can be at the other end, not just a “user.”
Also, this year saw Dave’s appointment as Unidata Director Emeritus, with approval from the UCAR Board of Trustees. Emeritus status is bestowed on people who have provided sustained leadership and impact on the UCAR organization. It clearly fits Dave who has served in various capacities within UCAR for over 38 years, including 18 years as the founding director of Unidata. Dave retired in 2005 and has continued to offer his time unselfishly to UCAR.

Major activities of Unidata focused on continued efforts in community engagement and broadening, facilitation of integrated data services, provision of new data streams, development of platform-independent software, and deployment of Unidata technologies in diverse environments.

Adequately summarizing the vast array of activities across the breadth of Unidata is a challenging task. This report provides an update on some of the salient activities of the Unidata program during the last year, highlighting its important accomplishments.

**Background**

The university community conceived and established Unidata, sponsored primarily by the NSF, nearly a quarter of a century ago to acquire and distribute real-time weather data and related software to U.S. universities.

Today, over several hundred institutions worldwide participate in the Unidata data sharing network and use Unidata tools and technologies in education, research, and operations, and in the process solving a range of complex environmental problems facing science and society. While Unidata’s primary mission of serving the academic community remains unchanged through the years, the user base has broadened considerably, and its activities and responsibilities have grown as community needs have evolved.
As the enabler of a broad community, the Unidata Program Center (UPC):

- Acquires and distributes mostly real-time meteorological data for education and research
- Develops software for accessing, managing, analyzing, visualizing, and effectively using geosciences data
- Provides comprehensive support to users
- Conducts annual training workshops on Unidata software packages
- Facilitates advancement of standards, conventions, and interoperability
- Provides leadership in geosciences cyberinfrastructure and fosters technological change
- Assesses and responds to community needs
- Advocates on behalf of the university community on data issues and negotiates data agreements
- Fosters community interaction and engagement to promote sharing of data, tools, and ideas
- Grants equipment awards to universities to enable and enhance participation in Unidata

Unidata’s hallmark has been democratizing access to data and tools by serving both large and small institutions in higher education. The program benefits from the diversity of its user community, spanning the technological, educational, and scientific spectra. Unidata-provided cyberinfrastructure has enriched university courses, enhanced productivity of students and researchers, and transformed the culture in atmospheric science departments.

Unidata has experienced a gradual but natural evolution from a program focused primarily on synoptic scale meteorology to one that serves a broader geosciences community. Unidata has attracted a broader community because it has been successful in providing tools and services that are interoperable, extensible, platform independent, and free. The robustness and quality of Unidata tools and services have resulted in their use...
beyond a community of several hundred universities, by organizations such as the NW²S
and other weather agencies around the world, NOAA laboratories, NASA, NRL, and
ECMWF, as well as many companies in the private sector. In the process, Unidata has
matured into a cornerstone facility upon which the university geosciences community and
other stakeholders have come to rely.

As a facility for the university community, Unidata focuses on being responsive to
current and anticipated user needs of academia and aims to be efficient and nimble in
doing so. To achieve that, Unidata has emphasized a community-driven, consensus-
building process that provides a shared vision and the ability to address evolving
community needs.

By providing data, advancing its software suite, organizing opportunities to facilitate
exchange of ideas, and making cyberinfrastructure contributions, Unidata has become a
foundational facility for the atmospheric sciences community. Unidata’s value as a
cornerstone facility has been amply demonstrated by a sustained record of innovation, a
rich portfolio of tools and services, an actively-engaged community, strong governance,
mutually-beneficial collaborations, and the ubiquitous use of its services in all sectors.

Successful Review of the Core Funding Proposal to Sustain the Unidata Program

In April 2008, the UPC submitted a five year proposal “Unidata 2013: A Transformative
Community Facility for the Atmospheric and Related Sciences” to the NSF to continue
and enhance Unidata’s role as a foundational facility (see
http://www.unidata.ucar.edu/staff/mohan/Project%20Summary_V2.pdf)

The proposal offered a bold vision and a realistic plan to extend the successes of a
national facility that empowers the community and enables transformative advances in
the geosciences. To that end, a 5-year plan for achieving the vision was provided through
six overarching themes that were shaped by pertinent scientific and education drivers,
consistent with community trends and needs, and aligned with the NSF priorities:

1. Broadening participation and expanding community services
2. Advancing data services
3. Developing and deploying useful tools
4. Enhancing user support services
5. Providing leadership in cyberinfrastructure
6. Promoting diversity by expanding opportunities

The proposed plan and endeavors therein were guided by the results of a comprehensive
strategic planning effort over the past year that included strong input from and leadership
by Unidata’s governing committees and feedback from the broader community. The
resulting strategy (http://www.unidata.ucar.edu/2007stratplan/Unidata.pdf) builds on the
successes of the present program, its capabilities and core competencies, and its unique

² Acronyms are described at http://www.unidata.ucar.edu/publications/acronyms/glossary.html
niche in providing robust, reliable, and comprehensive data services and tools to geoscience users.

Even as Unidata embarks on this plan to enhance and adapt its tools and services to meet the needs of an evolving community, the program remains deeply committed to meeting its responsibilities to the core atmospheric science community. The quality of services that the core community has come to expect will be maintained and enhanced as a result of the new partnerships and synergies.

Following a successful review of the proposal, the UPC is currently in negotiations with the NSF on the terms of the award and a stand-alone Cooperative Agreement for funding the program. The UPC will keep its community informed on the progress of its plans and activities as it engages users and stakeholders to shape its future plans.

Meanwhile, the following sections summarize our activities and accomplishments during the past year.

**Research enabled by Unidata**

Data and software provided by Unidata have contributed to numerous scientific studies and discoveries, as evidenced by the citation of Unidata and its offerings in 139 peer-reviewed and 277 conference papers in the last 5 years. The following list represents a cross-section of research enabled by Unidata:

- Climatology of mid-latitude cyclones and anticyclones over the United States
- Studies of tropical cyclone and hurricane life cycle and intensity estimation
- Variability of North American monsoon rainfall over complex terrain
- Studies of mesoscale convective vortices, tornadoes, and squall-lines
- Studies of fronts, cold-season precipitation events, and cold-air damming
- Validation of outgoing longwave radiation estimations with the GOES sounder
- Assessment of the ECMWF model cloudiness and surface radiation fields

Based on a March 2008 survey of a dozen doctoral programs in atmospheric sciences, it is estimated, *conservatively*, that more than half of the graduate students used Unidata systems in their research. Unidata’s impact on research extends also beyond the atmospheric sciences. For instance, Unidata systems and technologies are integral parts of community projects such as SuomiNet in the GPS applications arena, GEON and EarthScope in solid earth studies, and the multidisciplinary International Polar Year activities.
Latin American Data Workshop

Unidata, with funding from UOP’s JOSS program and in conjunction with the Universidade de São Paulo's (USP's) Instituto de Astronomia, Geofísica e Ciências Atmosféricas (IAG), hosted a Latin American Data Workshop on August 21-23, 2008 in the IAG facilities on the USP campus in São Paulo, Brazil.

The goals of the workshop were to:

- Foster scientific partnerships for exchanging knowledge and expertise among U.S. and Latin American educators and researchers
- Promote greater Latin American participation in free-and-open sharing of Earth System data
- Inform Latin American workshop participants of the wide variety of data available through the Abstract Data Distribution Environment (ADDE) and Thematic Real-time Environmental Distributed Data Services (THREDDS) servers (TDS)
- Inform Latin American workshop participants of the suite of freely-available analysis and display applications available through Unidata
The workshop was structured to include a combination of plenary, break-out and hands-on/demonstration sessions that focused on:

- Use of the Unidata LDM to connect to the IDD/IDD-Brasil data sharing networks
- Use of Unidata's TDS and McIDAS' ADDE capabilities for remote serving-of and access-to data
- Availability of real-time GOES imagery (imager and sounder), especially South American coverage from GOES-10
- Availability of high resolution, global GFS model data in the IDD CONDUIT datastream
- Availability of COSMIC global radio occultation (limb sounding) data by the LDM
- Availability of global observational data in the IDD IDS|DDPLUS datastream
- Strategies for sharing of locally-held datasets of general interest

The 45 workshop participants came from 18 organizations in 6 countries in South, Central, and North America. The workshop was as a resounding success and the attendees’ enthusiasm was evident as many of them stayed around until well after the scheduling ending time on a Saturday evening.

**Unidata Regional Workshop at Plymouth State University**

The Judd Gregg Meteorology Institute at Plymouth State University recently hosted a successful Unidata Regional Workshop. From May 18 to 20th over 25 participants representing 13 different educational institutions from 8 states across the U.S. met at the Boyd Science Center. Unidata software engineers Don Murray, Jeff McWhirter, and Yuan Ho provided hands on instruction with the Integrated Data Viewer (IDV), a visualization tool that provides the ability to perform three dimensional analyses of meteorological and other environmental data sets. Guest speakers from the National Oceanic and Atmospheric Administration (NOAA), Lyndon State College, and the U.S.
Geological Survey at Woods Hole Oceanographic Institute provided presentations on using the IDV in teaching and research.

Feedback from the workshop was positive. “This software should take care of my requirements for visualizing radar data,” said Sam Miller, a faculty member at Plymouth State. When asked whether the workshop met expectations, one participant wrote, “Yes, I learned a lot and became a much more comfortable IDV user.”

Computers used during the workshop were obtained with funding from a recent Unidata Equipment Award combined with cost matching funds provided by Plymouth State. They are being used in a variety of meteorology courses throughout PSU’s undergraduate and graduate programs, and they provide the next generation of visualization technology for PSU’s students.

The new systems made an impact on Plymouth State well before the workshop. “Our graduate students in Applied Meteorology have utilized the workstations for thesis based research on topics such as air quality monitoring and evaluation of road weather information systems in New Hampshire,” said James Koermer, Director of the Judd Gregg Meteorology Institute and Graduate Program Coordinator. He added, “The research performed with the new equipment also helps us satisfy our mission requirements as a regional public university by serving the people of the granite state.” Undergraduate students have benefited from the new technology as well by using it to perform research on such diverse topics as forecasting winds in the Gulf of Maine to seasonal frequency of fronts in the Great Lakes.

**Community Equipment Awards**

The Community Equipment Awards program funds new geoscience departments to join the Unidata community and to allow existing members to continue and enhance...
their participation. It is often regarded by the community as one of the best mechanisms for Unidata to promote diversity, as past awards tend to favor small institutions. Each year, the UPC sets aside $100K to fund the Unidata Community Equipment Awards program.

Since the UPC took over the program from NSF in 2003, this grants program has provided funds for equipment purchases to 40 universities. The program continues to receive strong support from NSF and the community and the UPC almost always is strongly encouraged to continue the grants.

This year’s program had a lower profile year but received another group of quality proposals. This year special consideration was given to proposals that further the use of Unidata tools and systems (e.g., THREDDS, NetCDF, IDV, GIS connections) to support education and research on various aspects of climate (e.g., diagnostics, change and impacts), including upgrades to existing classroom and laboratory equipment or procurement of new computers to support climate studies. Additionally, to enhance participation and advancement of underrepresented populations, proposals submitted by investigators in Community and Baccalaureate colleges and minority serving institutions were encouraged.

After careful review by a panel that included members of the Unidata Users Committee, the following three projects were funded in 2008:

- Embry-Riddle Aeronautical University, Dr. Christopher G. Herbster – “The Creation of a Community Resource for Weather Case Studies and Innovative Real-Time Weather Data for the IDD”
- Jackson State University, Loren D. White – “Unidata Equipment Proposal to Upgrade the JSU Meteorology High-Performance Computing Lab”
- Rutgers, The State University of New Jersey, Steven G. Decker - “Upgrading the Rutgers Weather Center to Meet Today’s Needs”

**Russell L. DeSouza Award**

The Russell L. DeSouza award, presented annually, honors a Unidata community member whose energy, expertise, and active involvement enable the Unidata Program to better serve geoscience. Honorees personify Unidata's ideal of a community that shares data, software, and ideas through computing and networking technologies.

This year’s award was presented to Dr. Mark J. Laufersweiler, University of Oklahoma, for working tirelessly to promote the use of computing technology both in and out of the classroom. His advocacy on behalf of Unidata tools and data and his entrainment of dozens of students through that advocacy have provided a robust cadre of new Unidata community members.

Mark served on the Unidata Users Committee for three years (2001-2004) and has encouraged students to attend Unidata users and training workshops. Mark co-chaired the 2003 Unidata Users workshop, Expanding Horizons: Using Environmental Data for

2008 Training Workshops

As it does each year, the UPC will conduct software training workshops from 30 October through 13 November at UCAR facilities. The workshop features Unidata’s display and analysis packages McIDAS, GEMPAK, and the IDV, data access and management tools, the Local Data Manager (LDM), the Network Common Data Form (netCDF), and the THREDDS software for cataloging, browsing, and accessing remote data and metadata. Unidata’s training workshops are developed and presented by the software developers and support staff for each package, so users can be sure to get their questions answered.

At this writing, there are a total of 56 registrants for the 2008 workshops. These registrants come from all over the world, while the majority is from the United States with 42; participants are coming from China, the Netherlands, Spain, Finland, Germany, South Korea, and Mexico. These registrants represent a wide array of organizations, with 18 working for a government agency, 12 for a university, 2 for the military, 21 for a research organization, and 3 from the private sector.

The Integrated Data Viewer (IDV) class has been extremely popular this year with a total of 29 people registered, and an oversubscription of 11 people. With the total class size being 18, this prompted the instructors to come to the decision to hold two 4-day sessions of the IDV course in order to accommodate all of the registrants. The THREDDS Data Server (TDS) course is also oversubscribed but with only one extra, the instructor will be able to ensure everyone will be able to attend the class. The overall breakdown of classes are as follows: Integrated Data Viewer (IDV) 29, THREDDS Data Server (TDS) 19, Network Common Data Form (netCDF for Developers) 27, and Local Data Manager (LDM) 14.
Data flows

During the past year, several update releases of the LDM were made to improve its performance and reliability as well as to fix bugs in the software. With the LDM advances and the broadening of the users community, Unidata distributed a record volume of data to the community far and wide on five continents during the past year. In fact, there has been a significant increase in data volume transmitted via Internet 2, largely due to the growth in the size of output from operational models and higher resolution data from the NEXRAD network. During the last year the Unidata IDD system delivered approximately 39 terabytes of data to approximately 250 educational, governmental, and commercial sites.

COSMIC Data Available on the LDM

During the year, the UPC made available GPS Radio Occultation data, using LDM technology, to the university community. This important addition to the Unidata-provided streams was made possible through a collaborative arrangement with UOP’s COSMIC program, and Taiwan's Formosa Satellite Mission. The data provides up to 2,500 radio occultation observations on vertical profiles of atmospheric air density, temperature, and water vapor as well as ionospheric electron density per day. COSMIC data provides unparalleled spatial and temporal resolution of sounding data. At this writing, over 20 universities are receiving the data. Ben Cotton, Purdue University, is enthusiastic about the addition of COSMIC data to Unidata's Internet Data Distribution system: "...acquiring the data via the LDM means we can use our existing infrastructure instead of having to set up a new system for retrieving and storing the data. A few quick edits to the LDM configuration files is all it takes to get the data flowing, and since we're just adding another data feed, no additional tasks or resources are needed to maintain and
monitor the feed. We're able to provide a whole type of data to our students and instructors at the cost of a few minutes of initial configuration."

**Community Highlights**

Luis M. Farfán is an atmospheric scientist at CICESE (Centro de Investigación Científica y de Educación Superior de Ensenada) in Mexico and an active member of Unidata’s community. He is a GEMPAK user, who plans to implement an LDM connection to receive regional-scale information during the summer months.

The weather on the southern Baja California Peninsula (where CICESE is located) is mild and dry most of the year. During the summer, humid air masses that move northward in the eastern Pacific Ocean provide favorable conditions for the development of localized, convective systems that result in rainfall episodes. Eventually, there are tropical cyclones that approach the northwest coast of Mexico. These systems tend to occur late in the summer and, upon landfall, they generate heavy precipitation and strong winds that cause significant property damage to the local population.
The Department of Meteorology at the University of Utah has actively participated in the Unidata program in a number of ways since its inception. In 1997, an equipment grant from the National Science Foundation’s Unidata Grant Program, provided workstations for our student computer laboratory. However, despite periodic updates, the core infrastructure had become complicated, cumbersome, and obsolete. In addition, installation of new equipment and maintenance of existing equipment had overwhelmed our in-house information technology staff.

Support from the Unidata 2007 Equipment Grant program, now administered by Unidata and renamed the Equipment Award program, provided the spark for a complete redesign of the department’s computational infrastructure during the past year. Integrating automated surface observations from as many sources as possible with analysis and forecast model output, as well as satellite and radar imagery, using data and tools from Unidata, is critical for students to visualize and understand the impacts of weather where it matters, the Earth’s surface. Access to surface observations from mesonets is particularly useful for assessing such weather impacts.

**Analysis and Visualization Tools**

Unidata’s reputation is most strongly linked to software tools that are used to access, analyze, visualize, integrate, interpret, and explore geoscience data. Unidata currently develops and maintains three tools for analysis and visualization: GEMPAK, McIDAS, and IDV. These tools are being employed widely (300 institutions for GEMPAK and 200 for IDV) in education and research as well as operational meteorology. The IDV is also being used in hydrology, oceanography, and other geosciences.

As part of its software development philosophy, Unidata emphasizes object-oriented, platform-independent, and open-source approaches to tool development, and use of open
standards. Some tools (e.g., IDV) are developed at the Unidata Program Center, while others (McIDAS and GEMPAK) originate elsewhere, but are modified, maintained, and supported by the UPC. Each application has its strengths and limitations and a community of users, but all three packages have become mainstays in university classrooms and labs. Typically, Unidata sites use a combination of GEMPAK, McIDAS, and IDV to meet different needs.

The NWS is embarking on a project to develop the next generation Advanced Weather Interactive Processing System, AWIPS-II, to be completed in 2011. An important component of AWIPS-II is integration of N-AWIPS functionality to AWIPS-II. Because of the development of the migrated N-AWIPS the current N-AWIPS package was frozen in summer 2008.

The impending moratorium on further N-AWIPS development is expected to impact GEMPAK users. In response, the UPC is working with N-AWIPS and AWIPS-II developers on strategies for a smooth transition plan for GEMPAK users. In the near term, the UPC will continue support of GEMPAK’s use in universities. In the long term (3-5 year time frame), the UPC will announce a transition away from GEMPAK, while providing support for the final NCEP release until a replacement is available for the university community. GEMPAK users will be encouraged to transition to the IDV by enhanced user training and the addition of GEMPAK-like capabilities in the IDV. Simultaneously, the UPC will work with the NWS and NCEP to investigate the possibility of bringing AWIPS-II to the university community and providing support for it. Given its expected capabilities, the academic community is likely to be interested in using AWIPS II. The UPC will seek guidance from our governing committees and input from our users in making decisions on AWIPS-II support.

**Synergistic activities that complement the core effort**

To maintain a vibrant program, the UPC, from time to time, participates in certain research and development projects that are tied to its overall mission but funded
separately from the core program. Such synergistic activities are both essential and complementary to the core effort, and both the Policy Committee and NSF encourage them. The UPC undertakes non-core projects only after careful analysis of their merit and benefits to the community and upon endorsement by the Policy Committee.

Such projects have played a vital role in advancing the program in new directions, creating new capabilities for the community, enhancing interoperability of Unidata software, providing new datasets to the community, and entraining and diffusing innovative ideas and technologies into the community. Almost always, synergistic projects leverage ongoing activities in the core program, are conducted in collaboration with other partners, and allow the UPC to offer its technologies and expertise for the greater benefit of the community (e.g., CADIS, an IPY project). In addition to their intrinsic merit, the projects have also helped to relieve pressure on the ATM-funded portion of the overall Unidata budget. Over the past five years, such projects have been kept to a modest level of about 15% of the overall effort. Below we highlight a few examples of synergistic activities that have greatly benefited the Unidata community.

The THREDDS project began as a separately sponsored non-core effort, with funding from the NSF EHR’s NSDL program. The project develops middleware and infrastructure to bridge the gap between data providers and data users. Today, THREDDS is an integral part of the UPC portfolio and an important community resource. Similarly, the effort to merge netCDF and HDF5, a capability long desired in the atmospheric science community, was possible only with funding from NASA. That effort also provided the motivation for developing the CDM, a key underpinning for a new version of the netCDF software and the TDS.

Linked Environments for Atmospheric Discovery (LEAD) is a collaborative, NSF-funded Information Technology Research (ITR) grant. LEAD involves nine institutions that bring different expertise (e.g., meteorology, computer science, grid computing, pedagogy, and data services) to develop a new paradigm for on-demand weather prediction. To that end, LEAD is creating an integrated, scalable framework in which meteorological analysis tools, forecast models, and data repositories can operate as dynamically adaptive, on-demand, grid-enabled systems. In addition to providing many of the technical underpinnings like LDM, THREDDS, and IDV, Unidata is playing a pivotal role in LEAD’s deployment in the meteorological community. The Unidata LEAD testbed has become a valuable community resource, providing a 180-day archive of many IDD-delivered data sets. The LEAD use cases have provided opportunities for enhancement of tools like the IDV and TDS. And most importantly, Unidata universities have begun to use the LEAD system for making on-demand weather predictions for a number of different applications.

In summary, the UPC recognizes the mutual benefits of synergistic activities that harness the strengths of innovative projects that are funded outside the core program through targeted opportunities. Unidata will continue to pursue such opportunities as they arise during the period of performance of this proposal, but as always, any new activity will be reviewed and carefully balanced against the core effort.